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## (54) Belt tensioner

(57) A belt tensioner of the Zed type with a pivot-arm (28), a pulley (12) attached to the pivot-arm for receiving a belt load, a pivot, a base (24), and a torsion spring (26) operatively connected between the pivot-arm and base and wherein damping of the pivot-arm is primarily provided by a pivot bushing (52) in response to the belt load

and a force generated by the spring. An annular member (46) attached to the arm is received in an annular cavity (38) in the base, the pivot bushing being interpositioned between a radially outer surface (54) of the annular member (46) and a radially inner surface (56) of the base.

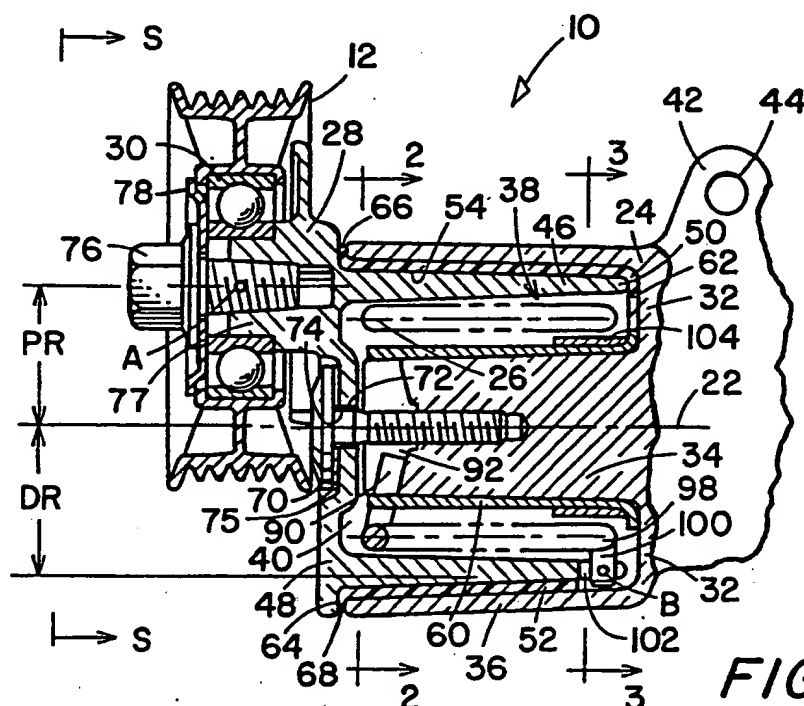


FIG. 1

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## Description

### Background of the Invention

[0001] The invention relates to an automatic belt tensioner with a torsional spring that biases the position of a pivot-arm to which a belt engaging pulley is attached, but more particularly, the invention relates to a tensioner of the "Zed" type where a radial center plane for the pulley is laterally offset from an axis for a pivot about which the pivot-arm oscillates.

[0002] Automatic belt tensioners have a pivot-arm that pivots relative to a base. A pulley is rotatably mounted to the pivot-arm and a spring between the pivot-arm and base biases the position of the pivot-arm to place the pulley against an endless belt of a belt drive system to tension the belt while receiving a belt induced load. In some applications, it is preferred to have a bushing for the pivot to be in a common radial plane with the pulley to simplify or reduce loads that must be carried by the bushing. Within this category of tensioners, there is a type that has a bushing that provides both bearing support and damping to pivoted oscillatory movements of a pivot-arm. Such a tensioner is disclosed in U.S. Patent No. 4,723,934 (B 1 4,723,934). Another example of a tensioner that has a bushing that provides both bearing support and damping to pivotal movements of a pivot-arm is disclosed in U.S. Patent No. 5,478,285.

[0003] An example of a "Zed" type tensioner is disclosed in U.S. Patent No. 4,473,362 where the tensioner has a pivot-arm attached to an off-set annular pivot member that supports the pivot-arm and oscillates on a post secured to a base. A torsion spring is used where one end of the spring is constrained at two points by a connection to the pivot-arm, and the other end of the spring is constrained by one connection to the base and one connection by way of a damping mechanism that includes a coil of the spring that presses against a sleeve which in turn presses against the annular pivot member. A single sleeve-type bushing located radially inward of the spring and positioned between the post and annular member, has a bearing surface that supports the annular member with its interconnected pivot-arm. The pivot bushing in connection with the damping mechanism, damps oscillatory movements of the pivot-arm. A problem with this type of tensioner is that the amount of available damping is somewhat limited because the pivot bushing and damping mechanism are located radially inward of the torsion spring and operate at a radius that is substantially less than the length of the pivot-arm.

[0004] Another example of a "Zed" type tensioner is disclosed in U.S. Patent application No. 08/828,216 and has: a pivot-arm, a pivot-pin connected on one side to the pivot-arm, a base member of generally "tube-pan" shape holding at least one low friction bushing that supports the pivot-pin, a torsional spring with one end constrained and attached to the pivot-arm and another end

constrained and attached to the base. The tensioner has a damping mechanism where an end of the spring is operatively connected to a damping mechanism that includes a shoe with an outside friction surface that rubs against an inside wall of the base member to effect damping. A characteristic associated with tensioners of this type is that substantially all of the damping is by way of the damping mechanism; very little damping is generated at the pivot bushing in response to a belt load received at a pulley.

### SUMMARY OF THE INVENTION

[0005] In accordance with the invention, a tensioner is provided that is useful in V-ribbed front-end accessory belt drive systems used in automotive applications. The belt tensioner of the invention is of the "Zed" type with: a pivot-arm, a pulley attached to the pivot-arm for engaging the belt and receiving a belt load, a pivot in a form of a cantilevered annular pivot member with a fixed end attached to the pivot-arm, at least one pivot bushing, a base member that supports the pivot, a torsion spring operatively connected between the pivot-arm and base and wherein both bearing support and damping to oscillatory movements of the pivot-arm is primarily provided by a pivot bushing.

[0006] The base has a bottom wall from which extends a cantilevered post and a cantilevered annular base member which together define an annular cavity. The annular pivot member is positioned inside the annular base member with the pivot bushing positioned therebetween.

[0007] A wide stance between the reactionary force of the belt load and the reactionary force of a spring load is achieved by the way that the torsion spring is operatively connected or "hooked up" to bias the position of the pivot-arm relative to the base. A first end of the spring is constrained between first and second places at an open or free end of the post. A second end of the spring is constrained between a place at the free end of the annular pivot member and a place juxtaposed the bottom wall of the base member.

[0008] The advantage of the spring "hook-up" is that it gives a wide stance for the reactionary forces carried by the bushing and results in a bushing wear that does not substantially inhibit alignment of the pulley over an operative life of the tensioner. Also, the spring "hook-up" is such that a belt force received at the pulley and a spring force at the annular pivot member combine to provide a damping force reacted at the pivot bushing.

[0009] Another advantage of the invention is that the pivot bushing is located radially outside the torsional spring to provide a high percentage damping.

[0010] These and other objects or advantages of the invention will be apparent after reviewing the drawings and description thereof wherein:

Figure 1 is a cross-sectional view of the tensioner

of the invention taken along the line of 1-1 of Figure 2;

Figure 2 is a partial schematic view taken in the direction S-S and cross-sectional view along the line 2-2 of Figure 1 illustrating various components and forces associated with the tensioner; and

Figure 3 is a partial schematic view taken in the direction S-S and cross-sectional view taken along the line 3-3 of Figure 1 illustrating various components and forces associated with the tensioner.

#### Description Of Preferred Embodiments

[0011] Referring to Figures 1-4, a tensioner 10 with a pulley 12 is typically used in conjunction with a belt drive system 14 that includes a belt 16 constrained by several pulleys (not shown) and a tensioner pulley 12. The pulley 12 engages the belt 16 to adjust belt tension. When engaged with the belt, the pulley 12 receives a belt load in the form of belt tension T1, T2 of adjacent belt spans, 18, 20. The belt tension T1, T2 (or load) combine to generate a belt force component BF along a bisector of an angle formed between the belt spans 18, 20 and acting symbolically at point A. The belt force component acting at point A, being axially offset from pivot-pin 22 of the tensioner, generates a complicated internal load that includes forces and moments. Tensioners with such an axial offset are known as of the "Zed" type.

[0012] The tensioner 10 is of the mechanical type and includes a base member 24, a torsion spring 26, a pivot-arm 28 that oscillates in relation to the pivot axis 22, and a ball bearing 30 attached to the pivot-arm for rotateably mounting the pulley 12.

[0013] The base member 24 has a bottom wall 32 from which extends a cantilevered post 34 and a cantilevered annular base member 36 that together define an annular cavity 38. The base member 24 has an open-end 40 and is oriented so that its bottom wall 32 and open-end 40 face toward the pivot-arm 28. One or more ears 42 with bolt receiving holes 44 may be integrally formed of the base member and used for attaching the tensioner with fasteners to an engine (not shown) to be part of the belt drive system 14.

[0014] A pivot in a form of a cantilevered annular pivot member 46 has a fixed end 48 formed as an integral part of the pivot-arm 28. An open-end of the annular pivot member protrudes into the annular cavity 38 such that the annular pivot member is positioned inside the annular base member 36.

[0015] At least one pivot bushing 52 of preferably the polymeric type is interpositioned between an outside surface 54 of the annular pivot member and an inside surface 56 of the annular base member. The bushing has an inside surface 58 that provides both bearing support and friction for damping to oscillatory sliding movements of the annular pivot member with the connected

pivot-arm. The pivot bushing, annular member, and annular base member have any complimentary shapes in relation to each other such as cylindrical or tapered.

[0016] A second bushing 60 also preferably of the polymeric type, is positioned over the post 34. Optionally, the pivot bushing and second bushing may be formed together as one composite bushing having generally a "tube-pan" shape.

[0017] An extension of the pivot-arm 28 and the integral fixed-end 48 may include a radial flat 64 extending circumferentially juxtaposed a wall 66 of the open-end 48 of the annular base member 36. Optionally, the pivot bushing includes a radial flange 68 positioned between the radial flat of the pivot-arm and the wall of the annular base member.

[0018] The pivot-arm 28 is secured to the cantilevered post 34 of the base member 24 by a fastener such as a bolt 70 or a stacked or riveted washer. The bolt 70 extends through a hole 72 formed in the pivot-arm 28 wherein the hole has a larger diameter than an outside diameter of the fastener to ensure a clearance 74 between the two parts. As assembled, the radial flange 68 operates as a thrust washer and dust shield between the base and the pivot-arm and also serves to help maintain a radial alignment of the pivot-arm in relation to the base member. A sealing disc 75 between the bolt head and pivot-arm acts as thrust washer that carries an axially extending load generated by the torsional spring upon assembly. The axially extending load helps improve spring tang hook-ups S1, S2 S3.

[0019] The pulley 12 is rotateably mounted to the pivot-arm 28 by means of the ball bearing 30 which is positioned on a stub-shaft 77 formed of the pivot-arm 28. The ball bearing 30 is retained on the stub-shaft by a fastener such as a bolt 76 and washer 78.

[0020] Optionally, a stop to limit annular movements of the pivot-arm may be included and formed between the base member and pivot-arm which is best illustrated in Figure 3. An arcuate cutout 80 is formed in the annular pivot member leaving radial walls 82, 84 as stops formed of a radial wall. A projection 86 formed of the bottom wall 32 of the base member protrudes into the arcuate cutout. The projection 86 in conjunction with stops 82, 84 formed of the annular pivot member limits oscillatory movements of the pivot-arm.

[0021] The torsion spring is located in the annular cavity 38 between the cantilevered post 34 and cantilevered base member 36 and is operatively connected to bias the position of the pivot-arm relative to the base member.

[0022] Referring more particularly to Figures 1 and 2, a first end 88 of the spring 26 has a tang 90 bent radially inwardly that extends into a slot 92 formed in the free end of the cantilevered post 34. A pin 94 is positioned in a second slot 96 formed in the free end of the cantilevered post 96. A first end of the spring is constrained between a first place S1 at the slot 92 and a second place S2 at the pin 94. All loads from the spring at places

S1, S2 are carried directly by the cantilevered post 34 of the base member 24.

[0023] Referring to Figures 1 and 3, a second end 98 of the spring 24 has a tang 100 bent radially outwardly that extends into a radial slot 102 formed in the free end of the annular pivot member 46. A sleeve 104 is positioned over the second bushing juxtaposed the bottom wall 32 of the base member. The second end of the spring is constrained between a third place S3 at the free end of the annular pivot member and a fourth place S4 at the sleeve juxtaposed the bottom wall of the base member. The load from the spring end at place S4 is transmitted to the sleeve 104, then to the second bushing 60, and then to the cantilevered post 34 of the base member. Tang 100 of the second spring end imparts a spring force FS to the annular pivot member at some point B which corresponds to where the spring is constrained at place S3.

[0024] The belt force imparted at point A and the spring force imparted at point B are in the same general direction and are carried by the annular pivot member. Pivot bushing 52 supports the annular pivot member whereby belt force BF and spring force FS are balanced by a reactionary force N. There is friction between the sliding surface of the annular pivot-arm member and pivot-arm bushing which acts to damp oscillatory movements of the pivot-arm. The sliding surfaces operate at a mean radius DR which may be larger or smaller than a radius PR of the pivot-arm. Both pivotal movements and damping are effected by the pivot bushing. There is a small amount of damping effected between the sleeve 104 and second bushing 60.

[0025] As more particularly illustrated in Figure 3, the location of the belt force BF moves from point A to point A' in conjunction with angular movements X of the pivot-arm. However, there is very little change in the direction of the belt force BF. The annular pivot member angularly moves with angular movements of the pivot-arm, and hence, the spring slot moves to a new location 106 as represented by the dotted lines at an angle Y (which is equal to angle X). The location of the spring force FS moves from point B to point B'. The force FS imparted by the spring at point B changes direction as it moves to point B' and remains substantially perpendicular to the slot at its new location 106.

[0026] The belt force BF and spring force FS combine to effect a damping force at the bushing that is balanced by the reactionary force N. The large diameter DR of the bushing (i.e. configured outside the torsion spring) along with its length suppresses wear and pulley misalignment.

[0027] The foregoing description is made for the purpose of illustration only and is not intended to limit the scope of the invention which is to be determined by the appended claims.

## Claims

1. A tensioner 10 for tensioning a power transmission belt 16 and of the type with a pivot-arm 28; a pulley 12 attached to the pivot-arm for engaging the belt and receiving a belt load; a pivot in the form of a cantilevered annular pivot member 46 with a fixed end 48 attached to the pivot-arm; at least one pivot bushing 52; a base member 24 that supports the pivot; a torsion spring 26 operatively connected to bias the position of the pivot-arm relative to the base member; friction between slideable surfaces for damping oscillatory movements of the pivot-arm; characterised in that

the base member 24 has a bottom wall 32 interconnecting a cantilevered post 34 and a cantilevered annular base member 46 that together define an annular cavity 38;

the annular pivot member 46 has an open end 50 that protrudes into the annular cavity 38 such that the annular pivot member is positioned inside the annular base member;

the pivot bushing 52 is interpositioned between an outside surface 54 of the annular pivot member and an inside surface 56 of the annular base member, and the bushing has an inside surface 58 that provides both bearing support and friction for damping to oscillatory sliding movements of the annular pivot member 46 with the connected pivot-arm; and

the spring 26 has a first end 88 constrained between first 51 and second 52 places at a free end of the post 34 and a second end 98 constrained between a third place 53 at the free end of the annular pivot member and a fourth place 54 juxtaposed the bottom wall 32 of the base member.

2. A tensioner as claimed in claim 1 wherein the second end 98 of the spring 26 is retained at a position on the annular pivot member 46 in a circumferential location such that a force F5 imparted by the spring to the third place 53 in combination with a belt force BF generated by the belt load generate a reactionary force N at the bushing to effect damping.
3. A tensioner as claimed in claim 1 or 2 wherein the post 34 has a substantially cylindrical surface portion juxtaposed the bottom wall 32, a post bushing 60 positioned over the post, and a sleeve 104 positioned over the post bushing juxtaposed the second end 98 and a coil of the spring 26, and wherein the cylindrical surface, post bushing and spring coil define the fourth place 54 juxtaposed the bottom wall

32 of the base member 24 where the second end 98 of the spring is constrained.

4. A tensioner as claimed in claim 3 wherein the pivot bushing 52 and post bushing 60 are formed together as one composite 62 having generally a tube-pan shape. 5
5. A tensioner as claimed in claim 3 or 4 wherein the pivot bushing 52, annular pivot member 46 and annular base member 36 are complimentary tapered in relation to each other. 10
6. A tensioner as claimed in claim 3, 4 or 5 wherein the pivot-arm 28 has a radial flat 64 extending circumferentially juxtaposed a wall 66 of the open end of the annular base member, and the pivot bushing 52 includes a radial flange 68 positioned between the radial flat of the pivot-arm and the wall of the open end of the annular base member. 15  
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7. A tensioner as claimed in any one of claims 3-6 wherein the base member 24 includes a projection 86 extending from the base wall and into an arcuate slot 102 formed in the open end of the annular pivot member 46, the slot and projection together restricting movement of the pivot-arm to a predetermined angular amount. 25

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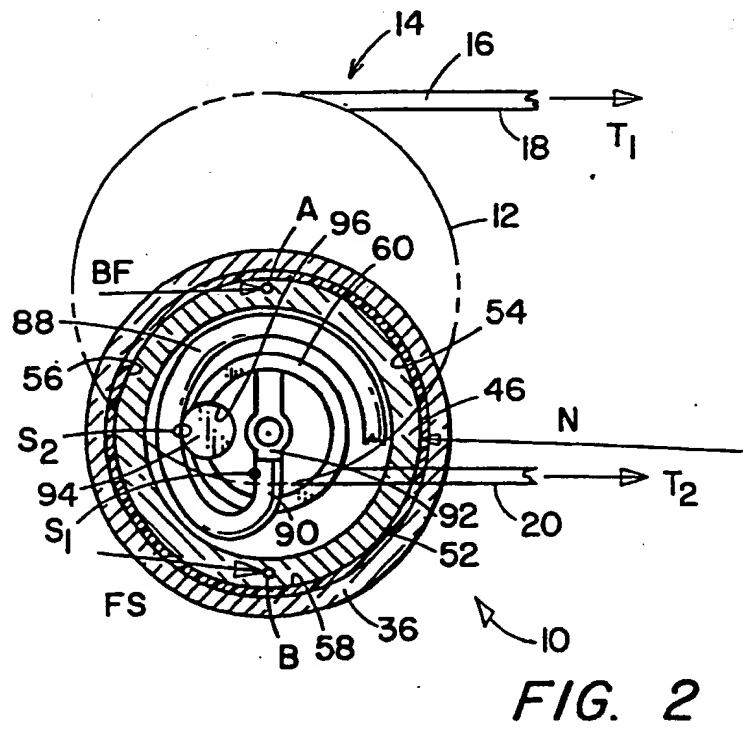
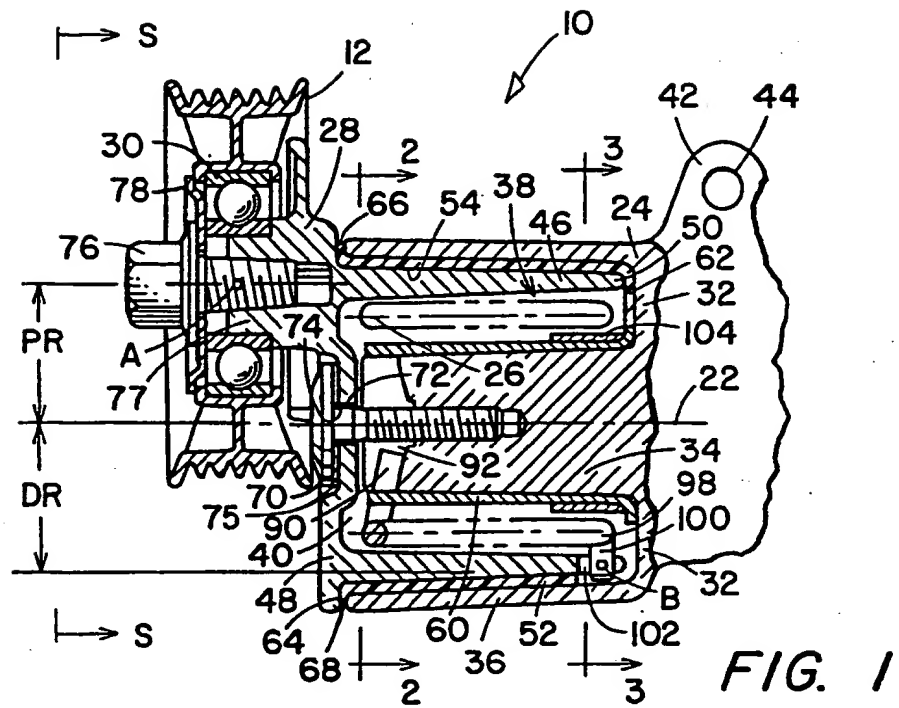
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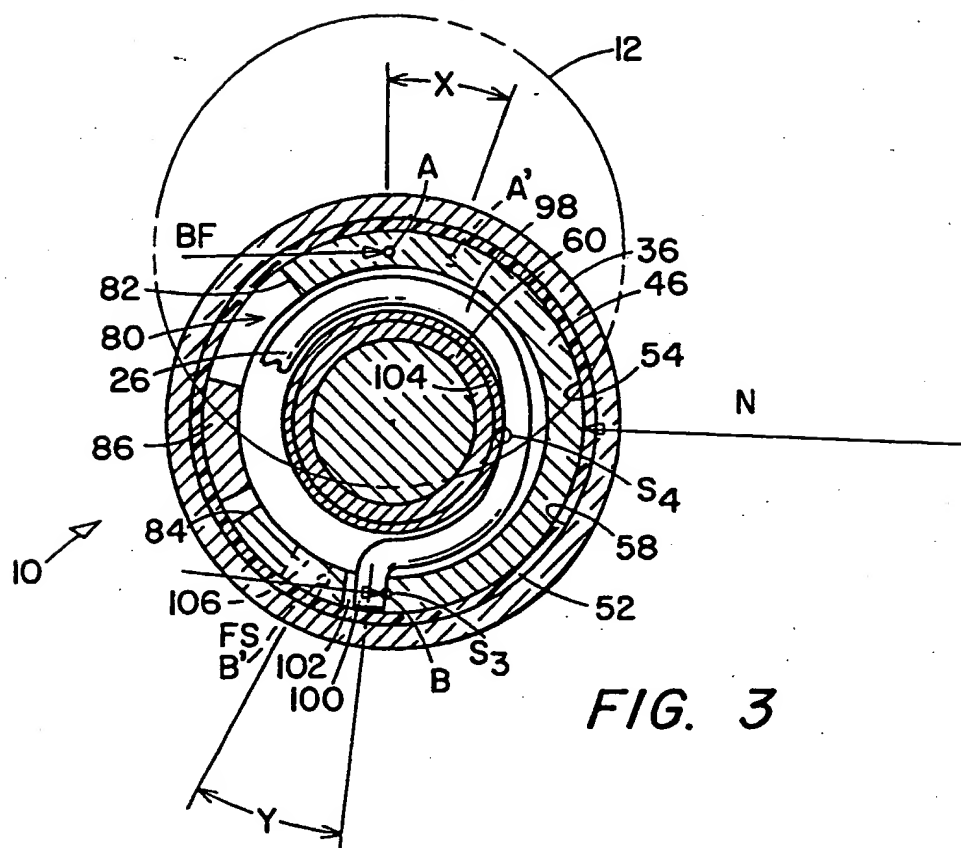
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## EUROPEAN SEARCH REPORT

Application Number  
EP 98 30 4919

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	DE 44 28 559 A (SCHAEFFLER WAEZLAGER KG) 15 February 1996 * column 2, line 31 - column 3, line 13 *	1	F16H7/12
A	EP 0 509 313 A (MAGNA INT GMBH) 21 October 1992 * figure 3 *	1	
A	GB 2 263 150 A (NTN TOYO BEARING CO LTD) 14 July 1993 * figure 2 *	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F16H
Place of search		Date of completion of the search	Examiner
BERLIN		18 January 1999	Hunt, A
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 98 30 4919

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